

# TRANSLATION OF EUROPEAN PATENT APPLICATION

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## Mechanical Bending Device and Mechanical Arrangement with this Type of Bending Device

The invention concerns a mechanical bending device for bending flat workpieces, especially sheet metal, with at least one bending tool, which has at least one part that can be moved by means of a drive, whereby the workpiece can be bent along a bending line when acted on by the moving tool part, and the moveable tool part contains segments, one after another, in the direction of the bending line. The invention also concerns a mechanical arrangement with the bending device described above.

The generic state of the art is document DE 196 40 124 A1. This prior publication discloses a bending machine with a swivel bending tool. A bending cheek of the swivel bending tool is provided with a bending cheek tool, which is in turn composed of tool sections arranged in a row in the direction of the bending line. Individual tool sections can be moved back and forth between the on and off positions. If the tool sections are in the on position, they act on the workpiece when the bending cheeks swivel and thus help bend it. When they go into the off position, the tool sections pass by the workpiece without deforming it. For tooling, the bending cheek is always swiveled with all tool sections, i.e., those in the on and off positions.

This invention is designed to advance the state of the art by making improved adjustment to changing applications possible.

The invention solves the problem with the mechanical bending device in Patent Claim 1 and the mechanical arrangement in Patent Claim 10.

In the case of the invention, at least one segment of the tool part is used which can be connected optionally to the bending drive. When the workpiece is being formed, the only segments of the tool part that are moved are those that are actually needed to produce the desired bend. The other segments of the tool part can stay in the resting position. The right bending tool is therefore available for each bending cycle and no tool change has is necessary.

Special embodiments of the invention are described in dependent patent claims 2 to 9.

In the design of the invention in Patent Claim 2, the bending tool swivels and has cheek segments that can be driven, if necessary. The advantage of using the swiveling bending tool in the invention is that only the curved workpiece arm leaves its starting position when the workpiece is being tooled. The rest of the workpiece can stay in its initial position during the tooling process, unlike press braking, for example.

In the interest of an effective, easy-to-build means of introducing the bending force needed for tooling the workpiece, the bending device in Claim 3 of the invention is built with at least one segment of the bending cheek as a two-arm swiveling lever with a bending arm and a drive arm.

The designs in Patent Claims 4 to 6 of the invention provide structurally easy-to-change ways of optionally making or breaking the drive connection between the movable segments of the tool part of the bending tool and the bending drive.

In another advantageous embodiment of the invention, according to Patent Claim 7, not only is the part of the tool that can move when the workpiece is being formed divided into segments, but so is the holding-down device assigned to that tool part. The segments of the holding-down device can optionally be connected to the drive of the holding-down device. A connection with the accompanying drive is made for those segments of the holding-down device and the bending cheeks that work together when a workpiece is being tooled. Accordingly, the workpiece is acted on by the holding-down device or segments of the holding-down device only in the area where the desired bend is to be made. Segments of the holding-down device arranged in other, roughly adjacent areas of the workpiece can be kept away from the workpiece. This possibility is a special advantage if a bend must be made close to a bend that already exists on the workpiece. If the action of the workpiece with the segments of the holding-down device is limited to the area of the workpiece with the additional bend, then unwanted deformation of the already existing bend is prevented by the segments of the holding-down device.

The model of the invention in Patent Claim 8 has the option of making bends in opposite directions on the workpiece being tooled. In the interest of a compact, inexpensive design, Patent Claim 9 provides that the drive of one bending tool and the drive of the holding-down device of the other bending tool have at least one drive element in common, at least on one side of the workpiece being tooled.

The invention will be explained in greater detail below with examples and highly schematic drawings.

Figure 1 shows a bending machine for machine-bending a piece of sheet metal

Figures 2 to 6 show the sequence of a bending cycle using the operating states produced thereby for a bending tool that can be used on the first type of bending machine in Figure 1.

Figures 7a to

7d and 8a to 8d show how the second type of bending tool works on the bending machine in Figure 1,

Figure 9 shows a double tool that can be used on the bending machine in Figure 1 and

Figure 10 shows a mechanical arrangement for machining sheet metal with a bending and a cutting station.

According to Figure 1, a bending machine 1 has a C-shaped frame 2 with a top arm 3 and a bottom arm 4. A conventional coordinate guide 5 is placed in the space on the bending machine 1 between the top arm 3 and the bottom arm 4 of the frame. A workpiece to be machined in the form of a piece of sheet metal 6 is held on the coordinate guide 5 by means of clips, not shown, and can move with the corresponding movement of the coordinate guide 5 in the horizontal plane of the sheet metal. When it is moved by the coordinate guide 5, the sheet metal 6 rests on a workpiece table 7 of the usual kind placed on top of the bottom arm 4.

The purpose of moving the sheet metal 6 with the coordinate guide 5 is to position it opposite a mechanical bending device in the form of a bending station 8 on the free end of the top arm 3. At bending station 8, folds 10 of different lengths are made along the bending lines 11 with a bending tool 9. Folded grooves 12 were cut free on three sides of the flat sheet metal 6 in the tooling cycle before the sheet metal 6 is bent. Grooves 13 still lying in the plane of the sheet metal 6 are also shown in Figure 1. The folding of one of these grooves 13 along a bending line 11 will be described below.

Figures 2 to 6 show the bending tool 9 as a swiveling bending tool with a bending cheek 14, a holding-down device 15 and a workpiece support 16. The bending cheek 14 is composed of five segments of bending cheeks 17, and the holding-down device 15 is composed of five segments of holding-down device 18. Both the segments of the bending cheeks 17 and the segments of the holding-down device 18 are lined up in a row in the direction of the bending line 11 defined by bending cheek 14 and work with holding-down device 15.

The segments of the bending cheeks 17 are designed as swiveling levers, and each has a bending arm 19 and a drive arm 20. They are mounted so they can swivel on a swivel axis 21 on a bending cheek holder 22 of bending station 8. The drive arms 20 are supported with their free ends on a control path 23, which is provided in turn on a control element 24. The control elements 24 can move in a straight line on the bending cheek holder 22. The control elements 24 can be connected to the piston 25 of a bending drive 27 via couplings 25. An individual coupling 25 is assigned to each control element 24. The couplings 25 can be engaged or disengaged by means of regulating devices, not shown, individually between the control elements 24 and the piston 26 of the bending drive 27. Alternately, the control elements 24 and the piston 26 of the bending drive 27 can also be coupled with a coupling that can be moved in the direction of the swivel axis 21 between the control elements 24 and the piston 26 and whose length is dimensioned in such a way that it can be arranged between one or more, or maximally all control elements, on one hand 24, and the piston 26, on the other hand. It is also conceivable to provide a shaft-like component for coupling the control elements 24 and the piston 26 whose axial direction runs parallel to the swivel axis 21 and which has shaft sections one after another in that direction that are assigned to different control elements 24 and in the circumferential direction of the shaft, radial projections staggered to one another, whereby depending on the rotational setting of the shaft to its axis, a different number of shaft sections is effective, and so a different number of control elements 24 is connected to the piston 26 by radial shaft projections.

The ratios on the holding-down device 15 are like those on the bending cheek 14. A coupling part 28 is assigned to each segment of the holding-down device 18. By means of a setting device, also not shown, the couplings 28 can be engaged or disengaged individually between the segments of the holding-down device 18 and the piston 29 of the drive of a holding-down device 30. The segments of the holding-down device 18 can move linearly in the direction of movement of the piston 29 on a holding-down device carrier 31. Corresponding to couplings 25, couplings 28 can be replaced by structurally different components to produce a drive connection between the piston 29 of the drive of the holding-down device 30 and the segments of the holding-down device 18.

The initial situation before the sheet metal 6 starts being machine-bent is shown in Figure 2. The sheet metal shown in dashes 6 lies on the workpiece support 16. The bending cheeks 14 and the bending cheek segments 17 are in their starting position. The holding-down device 15 and the segments of the holding-down device 18 are pulled back off the sheet metal 6. The couplings 25, 28 are engaged. There is therefore no drive connection between the segments of the bending cheeks 17 and the bending drive 27 and no drive connection between the segments of the holding-down device 18 and the drive of the holding-down device 30.

To prepare for the bending process, a number of couplings 25, 28 consistent with the length of the fold being made is engaged between the piston 26 of the bending drive 27 and the control elements 24 or between the segments of the holding-down device 18 and the piston 29 of the drive of the holding-down device 30.

In the example shown, two couplings 25, 28 are taken from their off position in Figure 2 into their on position in Figure 3.

Now, if the piston 26 of the bending drive 27 and the piston 29 of the drive of the holding-down device 30 are pushed in the direction of arrows 32, 33, the two couplings 25 engaged come to lie on the two assigned control elements 24 and the two couplings 28 engaged come to lie on the two accompanying segments of the holding-down device 18. Thus, the two segments of the holding-down device 18 are connected to the drive of the holding-down device 30, and the two control elements 24 and with them the two accompanying segments of the bending cheeks 17 are connected to the bending drive 27. The operating mode shown in Figure 4 exists.

Starting from these conditions, if the drive of the holding-down device 30 is activated, the segments of the holding-down device 18 previously activated, i.e., connected to the drive of the holding-down device 30 drop down onto the sheet metal 6. As a result of positioning the sheet metal 6 in relation to the bending station 8, the activated segments of the holding-down device 18 with their projecting ends come to lie in that area of the sheet metal 6 in which the flat groove 13 to be folded connects to the remaining sheet metal 6 (Figure 5). Because of the compressive pressure applied by the drive of the holding-down device 30, the sheet metal 6 is secured between the working segments of the holding-down device 18 and the workpiece support 16 against any movement.

Now, if the piston 26 of the bending drive 27 leaves its position in Figures 4, 5 and moves in the direction of arrow 32, the two activated control elements 24 are moved up on the figures. The accompanying segments of the bending cheeks 17 with their drive arms 20 thus slide along the tracks 23 of the two control elements 24. The two activated segments of the bending cheeks 17 consequently swivel on the swivel axis 21 and bend the groove 13 of the sheet metal 6 upward, as shown in Figure 6 with their bending arms 19. Thus, the desired fold is made, and the bending tool 9 can be sent back to its initial position in Figure 2 by a return stroke of the pistons 26, 29 and corresponding return movements of the bending cheek elements 17 and segments of the holding-down device 18 used for tooling the workpiece.

A bending tool 9a shown in Figures 7a to 7d and 8a to 8d differs from the bending tool 9 in Figures 2 to 6 basically in terms of the activation and operation of bending cheek 14a. Thus, to activate and deactivate swivel-lever-type segments of the bending cheeks 17a, a switching device 34 in the form of a regulating cylinder is used. Thus each segment of the bending cheeks 17a has its own regulating device 34 assigned to it.

Segments of the bending cheeks 17a that are to be used in subsequent machine tooling are pushed into a receptacle 35 on a driver 36 of a bending drive 27a by the switching device 34 on one drive arm 20a. If the driver 36 is then pushed out of its starting position in Figure 7a into its end position in Figure 7d, it takes the drive arm 20a or the bending cheek segment or segments 17a with it. As a result, the segments of the bending cheeks 17a in question swivel on their swivel axis 21 and deform the sheet metal 6 by means of a bending arm 19a in the way desired. Segments of the bending cheeks 17a that are not used when the sheet metal 6 is tooled are pushed out of the receptacle 35 on the driver 36 of the bending drive 27a by the respective switching device 34 or kept in the disengaged position. As shown in Figures 8a to 8d, the driver 36 is then pushed horizontally without the disengaged segments of the bending cheeks 17a swiveling on the axis 21 or the sheet metal 6 being deformed.

A double tool 37 shown in Figure 9 includes two bending tools 9 that correspond to one another in design and function and are arranged 180° from one another. On one and the same side of the sheet of metal 6 being machined therefore are a holding-down device 15 of the one bending tool 9 and a bending cheek 14 of the other bending tool 9. Because of this design, folds can be made in opposite directions on the bending tools 9. A groove of sheet metal 6 folded under is shown in Figure 9.

Couplings 25, 28 can be used on both sides of the sheet metal 6 optionally to activate a bending cheek 14 or to activate a holding-down device 15. Depending on which bending tool part is activated, a hydraulic drive works as a bending drive 27 with piston 26 or as the drive of a holding-down device 30 with piston 29.

In Figure 10, the bending station 8 is integrated into a mechanical arrangement 38 for machining sheet metal 6 that also includes a mechanical cutting device 39 for machine-cutting the sheet metal 6. The cutting device 39 is a punch in the example shown. Other conceivable examples are water, a plasma and/or laser-cutting devices. With the cutting device 39, first the grooves on three sides are cut free on the flat sheet metal 6. Then, the sheet metal 6 is positioned with the coordinate guide 5 opposite the bending station 8 in such a way that the flat grooves can be folded as shown by the bending station 8.

The machine functions are CNC-controlled on all the machine-tooling devices described above.

## Patent Claims

1. A mechanical bending device for bending flat workpieces, especially sheet metal (6), with at least one bending tool (9, 9a), which has at least one tool part that can be moved by means of a bending drive (27, 27a), wherein the workpiece can be bent along a bending line (11) by being acted on by the part of the tool that moves, and the movable part of the tool includes segments of the tool parts one after another in the direction of the bending line (11), characterized by the fact that at least one segment of the tool part can be connected optionally to the bending drive (27, 27a).
2. The mechanical bending device in Claim 1, characterized by the fact that a swiveling bending tool is provided as the bending tool (9, 9a) with a movable tool part in the form of a bending cheeks (14, 14a) that can swivel on a swivel axis (21) running in the direction of the bending line (11) and by the fact that the bending cheeks (14, 14a) contain segment of the tool parts in the form of segments of the bending cheeks (17, 17a), at least one of which can be optionally connected to the bending drive (27, 27a) and can be swiveled on the swivel axis (21) when the drive connection is made, and there is bending action on the workpiece.
3. The mechanical bending device in one of the preceding claims, characterized by the fact that at least one segment of the bending cheeks (17, 17a) is designed as a two-arm swiveling lever with a bending arm (19, 19a) provided on one side of the swivel axis (21) for acting on the workpiece and bending it, and with a drive arm (20, 20a) provided on the other side of the swivel axis (21), for optionally connecting the drive to the bending drive (27, 27a).
4. The mechanical bending device in one of the preceding claims, characterized by the fact that at least one swivel lever can be engaged by means of a switching device (34) on the drive arm side in a receptacle (35) on a driver (36) of the bending drive (27a) or disengaged from that receptacle (35), whereby the connection between the

swivel lever and the bending drive (27a) is made in the engaged mode and is broken in the disengaged mode.

5. The mechanical bending device in one of the preceding claims, characterized by the fact that it has a control element (24) with a track (23) between at least one swivel lever and the bending drive (27), whereby the swivel lever is supported on the drive arm side on the track (23) of the control (24), and it can be connected optionally to the bending drive on the bending drive side by means of a switching device, whereby when the drive connection is made between the control element (24) and the bending drive (27), the swivel lever is acted on by the control (24) via its track (23) on the drive arm side and can thereby swivel on the swivel axis (21) when there is bending action on the workpiece.

6. The mechanical bending device in one of the preceding claims, characterized by the fact that the switching device for optionally connecting the control (24) and the bending drive (27) has at least one coupling part (25) that can be engaged or disengaged between the control (24) and the bending drive (27), whereby the connection between the control (24) and the bending drive (27) is made with the coupling part (25) engaged and broken with the coupling part (25) disengaged.

7. The mechanical bending device in one of the preceding claims, characterized by the fact that the bending tool (9, 9a), designed as a swiveling bending tool, has a holding-down device (15) extending along the bending line (11), by means of which the workpiece can be acted on in the transverse direction of its flat extension and can thereby be fixed between the holding-down device (15) and a workpiece support (16) on the side of the workpiece opposite the holding-down device (15), and by the fact that the holding-down device (15) includes segments of the holding-down device (18) one after another in the direction of the bending line (11), at least one of which can optionally be connected to a drive of the holding-down device (30) and can be transferred into a position where it acts on the workpiece by producing a drive

connection, whereby when the workpiece is bent, segments of the holding-down device (18) and segments of the bending cheeks (17, 17a) working together at the same time with the drive of the holding-down device (30) or with the bending drive (27, 27a) are connected.

8. The mechanical bending device in one of the preceding claims, characterized by the fact that at least two bending tools (9) are provided in the form of swivel bending tools, each of which has a bending cheek (14) that can swivel, with at least one segment of the bending cheeks (17) that can be connected optionally to the bending drive (27) and a holding-down device (15), whereby the bending cheek (14) of one and the holding-down device (15) of the other bending tool (9) are arranged on one and the same side of the workpiece.

9. The mechanical bending device in one of the preceding claims, characterized by the fact that at least on one side of the workpiece, the holding-down device (15) has a drive (30), and the bending drive (27) of the one and the drive of the holding-down device (30) of the other bending tool (9) have at least one common drive element.

10. A mechanical arrangement for machining flat workpieces, especially sheet metal (6), characterized by the fact that at least one mechanical bending device (8) according to one of Claims 1 to 9 and also at least one mechanical cutting device (39) for machine-cutting workpieces are provided, whereby workpiece parts can be bent and machine-cut by means of the mechanical cutting device (39).

## Abstract

A mechanical bending device and a mechanical arrangement with this type of bending device.

A mechanical bending device (8) for bending flat workpieces, especially sheet metal (6), has at least one bending tool (9), which includes at least one tool part that can move by means of a bending drive (27). When acted on by the tool part that moves, the workpiece can be bent along a bending line (11). The movable tool part has segments of the tool parts one after another in the direction of the bending line (11), at least one of which can be connected optionally to the bending drive (27).

A mechanical arrangement for machining flat workpieces, especially sheet metal (6) includes, besides the mechanical bending device (8) described, a mechanical cutting device. On the mechanical bending device (8), workpiece parts can be bent and machine-cut by means of the mechanical cutting device.

(Figure 2)

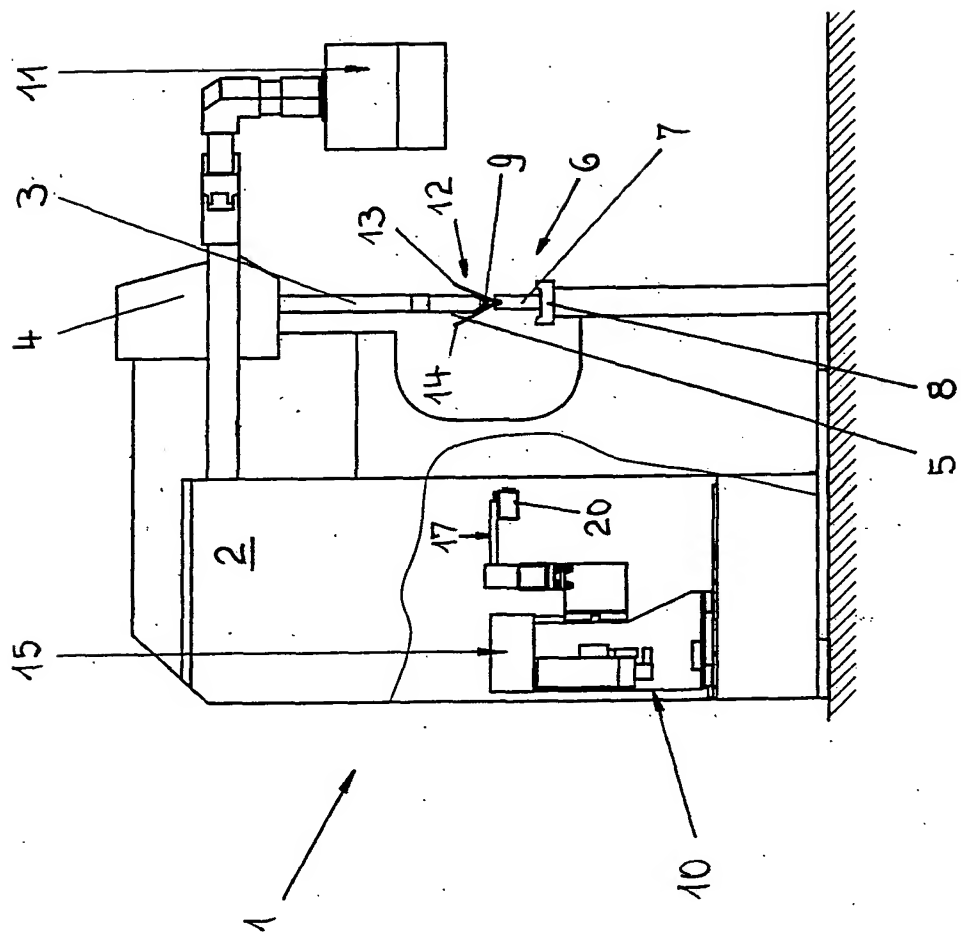


Fig. 1

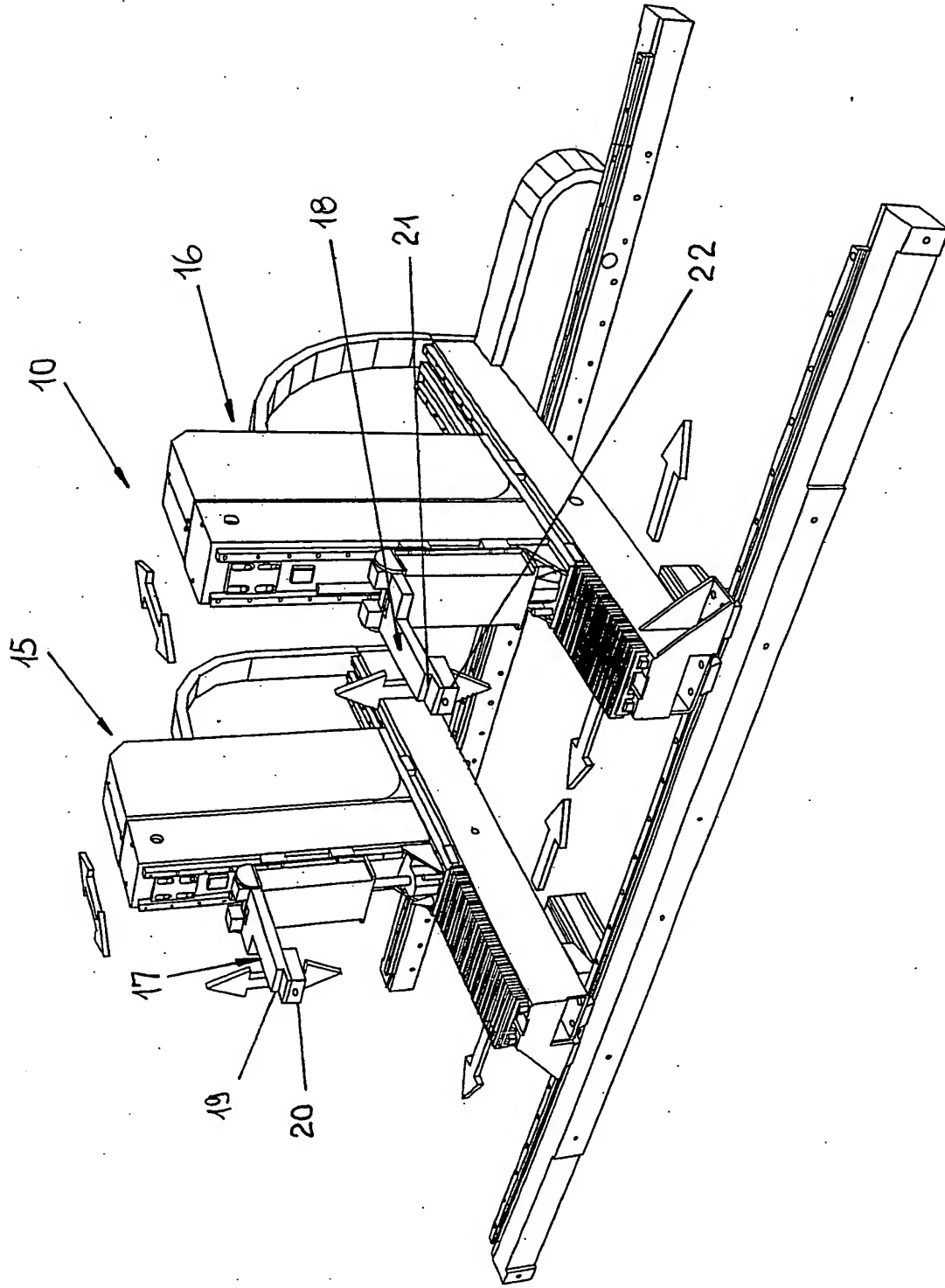
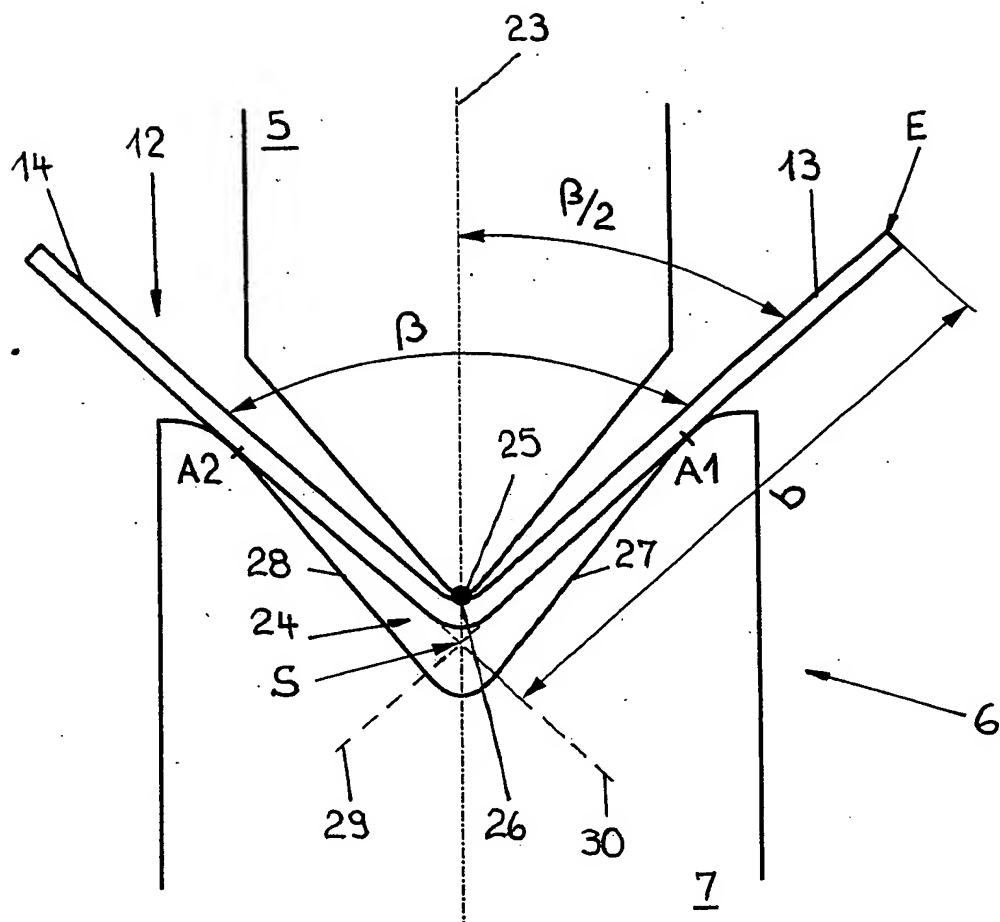
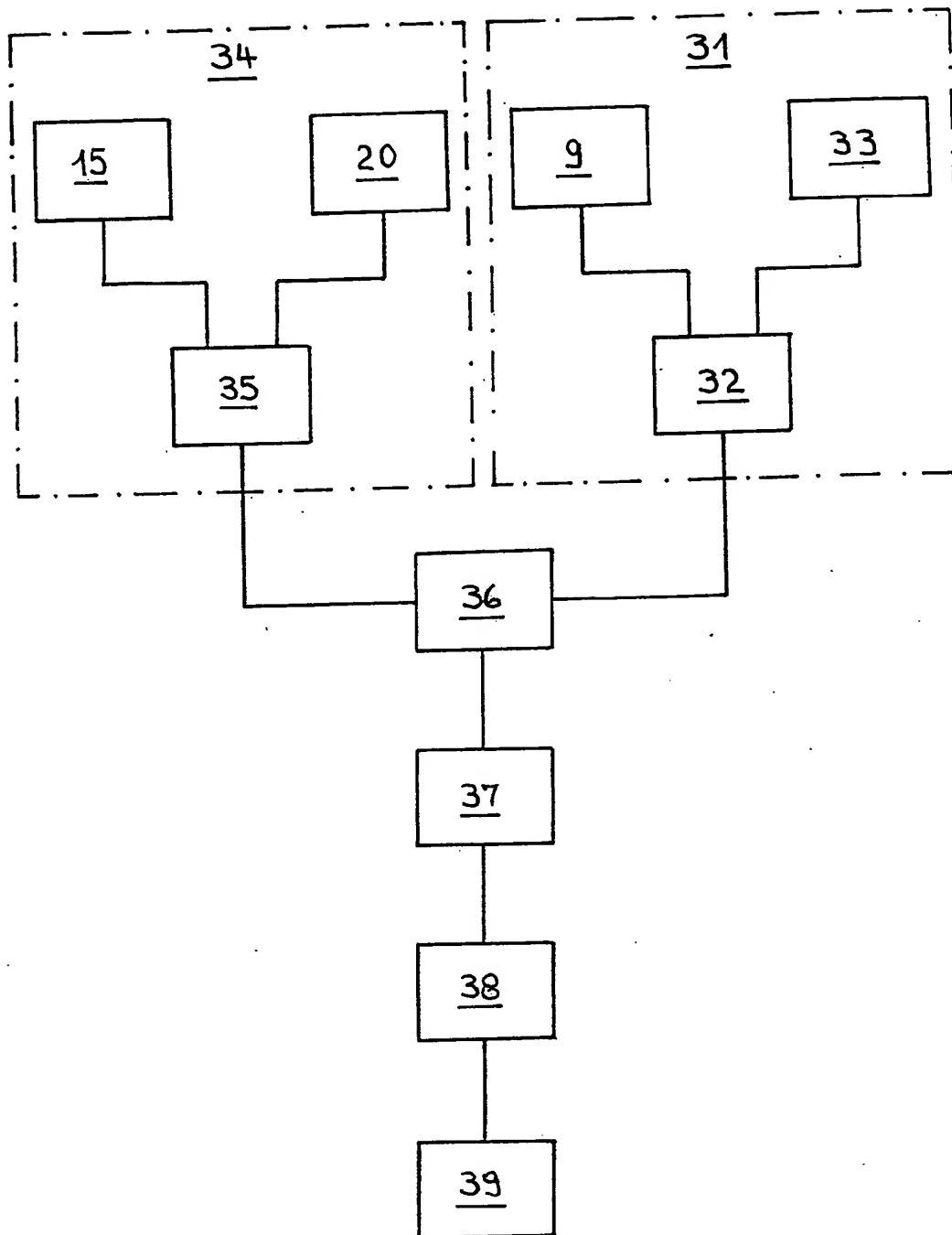


Fig. 2



**Fig. 3**



**Fig. 4**